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Sustainable Nanomaterials: A Greener Future Avenue?

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The field of nanoscience has experienced a staggering number of advances in recent years with regards to a wide range of disciplines including physics, chemistry, materials science, biology and medicine [1]. Although most of these are still closely related to laboratory practices and yet far from entrepreneurial activities, many of these nanomaterials are currently commercially available (e.g. silica nanowires, silicon wafers, carbon nanotubes, graphene and derivatives) and have paved the way to enormous developments in the preparation of functional nanomaterials for various applications [1,2]. Generally speaking, environment and sustainable considerations around the synthetic protocols currently in place for the fabrication of nanoentities are scarce and nanosafety procedures in terms of toxicity, handling of nanomaterials and their environmental impact are still not yet sufficiently developed (in the available cases). Considering the synthesis of some of these nanomaterials, protocols often involve high temperatures and pressures, the use of hazardous reagents and/or solvents or include little details to be accounted for in terms of environmental considerations (e.g. environmental impact, green metrics, handling risks, toxicity). Taking into account the essentially different nature and properties (often unknown) of such nanoentities, an increasing number of restrictions, handling practices and safety procedures are currently present in several laboratories and working places in which nanomaterials are handled on a daily basis [3,4]. A complete set of new and updated information on characteristics and properties (as well as risks and toxicity issues in their manipulation) is truly needed to better understand and establish the most acceptable working practices for nanotechnologies. However, a benign by design concept should be promoted in all nano-related practices, aiming to target the development of future sustainable nanoprotocols and environmentally compatible nanomaterials [5,6].

This editorial contribution advocates for more thoughtful and carefully design methodologies that take into account environmentally sound protocols for nanomaterials development. These should range from low temperature ambient pressure methods, avoidance of hazardous chemicals, solvent-free protocols to alternative greener technologies such as mechanochemistry-ball milling-[7], microwave irradiation [2,8,9] and sonication [10] as well as life cycle and risks assessments (whenever possible and appropriate) [11] to analyse and considerate toxicity, risks and environmental impact of the synthesis, handling and utilization of nanomaterials in our daily practices in view of a future implementation of nanotechnologies in our future society [12].

In any case, judging from recently developments in the field, the era of environmentally compatible nanomaterials for future sustainable applications is envisaged to be part of a more sustainable and economically competitive society which this author particularly hopes to enjoy as a reality within the next 30 years.

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